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AERONAUTICAL KNOWLEDGE

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The Miraculous Power of Rocket-Gun

By
Wang Wei

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On February 17, 1979, the Chinese frontier troops in Yunnan and Guangxi were ordered to launch a self-defensive counterattack against the Vietnamese intrusion. In the fighting, the rocket-gun units in the Chinese army in the front successfully destroyed the defense works well constructed by the enemy for years and bombed the enemy to flee ignominiously by their compact and continuous firing. They made distinguished records of their service in the war by effectively supporting the ground troops to make attack. So all of the foot soldiers commended that the firing made by their comrades in the rocket-gun units was in time, accurate, powerful and above all miraculous.

From the report of combat performance submitted by the second battalion of a rocket-gun regiment in the Guangxi frontier forces, we can learn how have the heroes in that rocket-gun unit performed their duties.

The members of the second battalion were assigned separately to four infantry units and fought back and forth around such places as Phuc Hoa, Dong Khe, Cao Bang, Quang Uyen and Thong Nong. They destroyed and suppressed four artillery positions of the enemy, one commanding post, ten supporting points and one obstruction point. In fighting, they coordinated closely with the infantry, and their firing aimed at whatever the infantry required. On February 17, when a unit of the infantry tried to attack the city seat of Phuc Hoa, the unit found out that they were under serious threat of enemy's gun fire. At this time, an observer from the second battalion figured out the direction and distance of enemy's artillery position and the rocket-gun unit used their fierce fire power to suppress the enemy immediately and supported the infantry unit to make their attack. On February 19, one unit from the infantry was marching on to the front and suddenly blocked by the enemy from an isolated hill. The height of the hill is about 230 meters and it is situated like the horizontal stroke of a capital "A". The enemy held the forked roads. Also they constructed defense works of upper, middle and lower, three layers so they could form their firing into a tight fire net-work. Moreover, around the hill is an open plain so it would be very hard to go close to it. As the foot soldiers had been blocked there, they urgently needed support of gun power from other units. As soon as the order to support that unit came, the second battalion began to hold an advisory meeting to study how to carry out their mission. They were well prepared and there was even no need for test-fire, in only about ten minutes, they poured hundreds of shells onto the top of the hill, and the noisy and stubborn enemy was devastatingly silenced immediately. Then the infantry started their attack and easily took over the hill. Thus they opened a way for the successively coming troops. The foot soldiers repeatedly praised the second battalion, saying "Their firing is really marvellous and miraculous!"

In order quickly and accurately to report the enemy's situation to the gunners and direct them to shoot, the wire communication group, the wireless communication group and the drivers in the second battalion coordinated with each other closely. The computation group computed that it needed 996 shots aiming at the 320 targets. It proved all correct. The wire communication group braved enemy's gun fire for 17 times to set up communication line of 149 kilometers by way of overcoming 315 obstacles. The wireless group insured the smooth flow of communications and they received and sent out more than twenty-two hundred informations and more than 66,000 units without any error. They timely and accurately directed 14 battalions to shoot simultaneously for twenty times, and all the shots hit their targets. Consequently, they made their distinguished records in this war.

The commander of this battalion was a determined fighter so he was able to lead fighting gallantly and stubbornly. When the fighting became so tense that there was no time to wipe the shells clean, the soldiers often cleaned them by using the front part of their jackets while they were carrying the shells, each of which weighted more than 80 kilograms. Then they put the shell into the gun barrel immediately. Sometimes, some soldier fainted due to the strong nitro-smoke, but soon he got up and went to resume his work. Soldiers often fell down to the ground because of the powerful air wave but they never failed to get up and to continue their fighting. The gun position of this battalion was attacked four times, but the commander led fearlessly and persistently to continue their counterattack. Once, in the night, this battalion received an order to change their position and to coordinate with an infantry unit to fight enemy, they made their move without any delay and, in the rainy night, they marched more than twenty kilometers in the dark. When they reached their destination, they moved to occupy their position immediately. At four o'clock next morning, the infantry commander gave them an order, their rocket-guns began to roar and pour their shells to overwhelm the enemy.

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The powerfulness of the rocket-gun displayed in the self-defensive counterattack against Vietnamese led us to recall the performance in the battle fields of a new weapon "katusha" which was first equipped by the Soviet troops during the late stage of World War II. Now "katusha" has become an item of museum. But, however, it has been used as basis to develop many different types of rocket-gun and the ground troops of many countries have been equipped with such weapon.

Why is a rocket-gun so powerful? What kind of weapon is it after all? The answers to these questions will be given in the following.

A rocket-gun is a kind of ground-to-ground multi-piped rocket weapon system, and it is a kind of gun of an artillery unit. The rocket-gun battalion of a corps or a division is always equipped with it.

The firing range of a rocket-gun is often from several kilometers to twenty or thirty kilometers; its moving speed is similar to that of a cross-country truck or an armoured vehicle; and the number of pipes runs from a few, more than ten to several tens. The speed of firing rocket shell is very great, and it can fire a few or more than ten shells in a very short time and even several ten shells can be fired simultaneously. The launching stand can be pulled or automated. The automated launching stand is usually set on a cross-country truck or a caterpillared vehicle. In addition, some of the ground-to-ground rocket shells can be airborne (see Figure 3). The diameter of the rocket shell is usually 100 - 140mm but a small number of them can have a diameter of more than 200mm or less than 100mm. The structure of the shell is of two different kinds: the turbo-shell and the tailed shell. Around the fifties, the turbo-shells constitute a larger number but after the sixties, the tailed shells become more. Most of the launchers are pipe-typed and there are also launchers of rail-type. On the rocket shell, there is no guiding unit, it is therefore called non-controlled rocket shell. The firing spread of this weapon system is rather large, and consequently its accuracy is not very good. Nevertheless, the facts that the firing speed is great and its firepower is fierce can compensate such defects. So it is still the important supporting weapon system in artillery warfare today.

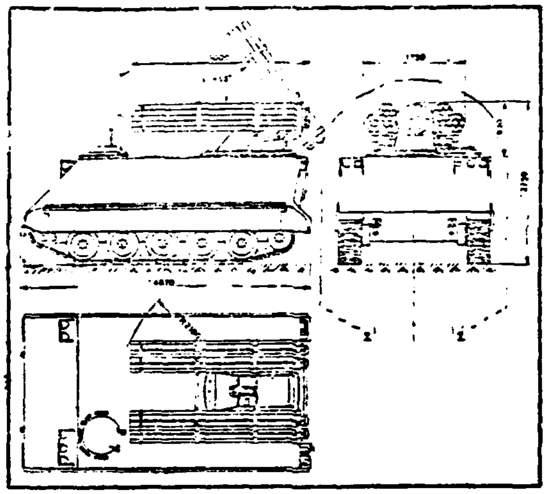

Figure 1 The pipe-type rocket shell carried on a caterpillared vehicle

The Composition of Rocket-gun

Rocket-gun is a general name of the multi-pipe rocket weapon system and its components include two major parts: the rocket-gun and rocket shell.

A rocket-gun is composed of:

Orientation Unit. It carries rocket shell and decides the direction to which the shell ought to fly. It is composed of orientation pipe (rail), shell obstruction unit, conduction unit, a pulling bar and framework.

Rotation Disk. It consists of direction device, lifter, and balancer. The rotation disk is the main body of the revolving part of a rocket shell (see Figure 1), and its use is to hold the orientation unit, direction device, lifter and balancer. It is composed of rotating device, bearing and bottom seat.

Aiming Unit. It is used to aim at target and to determine the number of rounds of shot.

Ignition System. It is used to fire rocket shell and it is composed of igniter, electricity source, wiring box and the launcher outside the vehicle.

Rocket Shell Vehicle. Usually it is a cross-country truck (see Figure 2) or a caterpillared vehicle and the vehicle is always equipped with a jack, a fixing device, a fender, seats, instrument box, protection plate and signal lamp.

Figure 2 The pipe launched rocket shell carried on wheeled truck

The Composition of Rocket Shell

Each rocket shell has its unique characteristic, but, in structure, there are many common points among various rocket shells. Generally, rocket shell is composed of four components: the fuse, warhead, engine and tail (except for turbo-shell) (see Figure 3).

Fuse. It is a unit which helps the warhead to produce full combating effect by making it explode completely and in time. It can enable the shell powder to explode at a prescibed time and place. A fuse is usually set up on the head of a rocket shell.

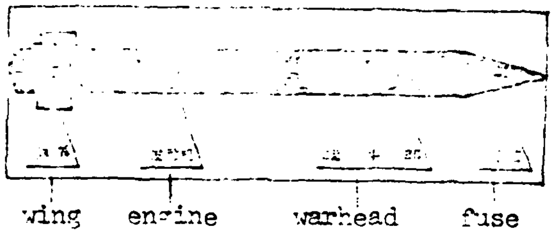

Figure 3 Diagram of the structure of a rocket shell

Warhead. It is used to destroy target, to kill people and to complete other tactical mission, such as rocket mine-sweeping. The head of a rocket shell is called warhead. The warhead is usually set at the front part of a rocket shell and the destruction force of a rocket shell is produced by the warhead.

A warhead is composed mainly of a shell and the warhead powder which is made of high energy explosive powder. In addition, there are small steel and other filling materials (mine).

Engine. It is the power for flying of a rocket shell, and it is set behind the warhead.

The engine of a rocket consists of a shell (also called combustor) and propellent (also called launching powder). The shell is a thin walled shell structure made of materials which has high temperature (2500°C above) and high pressure (several tens to several hundred atmospherical pressure) resistance and the propellent powder charge is placed in it. This small sized rocket propellent uses a geometerical shape powder charge. It will produce a high temperature and high pressure gas, which comes out from the tail nozzle of the engine by a high speed to propel the rocket shell flying foreword.

Tail. It is set at the tail end of the engine and it is a unit used to stabilize the rocket shell flight. It maintains a certain oblique angle on the shell so that it can guarantee a speed of revolution in the whole flight of the rocket shell. Thus the aerodynamical performance of a rocket shell can be improved and so is its accuracy.

The Mission of a Rocket-gun

The important mission of a rocket-gun includes:

To destroy and suppress enemy's assembled fighting force and tactical weapons.

To destroy and suppress enemy's tanks, armoured vehicles and landing equipment.

To suppress and destroy enemy's fighting force hidden in a shelter.

To suppress and destroy enemy's artillery, mortar unit and chemical weapons.

The Merits of a Rocket-gun

The firing force is instantaneous and fierce. In a period of 10 - 20 seconds, a rocket-gun can fire several to several tens or even more than forty rocket shells. Comparing the effect of attacking target of a general gun with a rocket-gun, we can know the difference. A set of eight 40-pipe rocket-guns, in a period of 20 seconds, can fire 320 rocket shells. A general gun in the same period of time can fire only three shells. Therefore, 106 general guns can deliver a fire force equal to that of 8 rocket-guns in the same period of time. Because several pipes of a rocket-gun can fire simultaneously, it can form a strong density of fire force in a short time, so it can give enemy a devastating attack and a powerful threat.

The mobility is good. The firing stand of rocket-gun can be set onto a cross-country truck or a caterpillared vehicle. On the other hand, a rocket-gun has larger directional firing range and altitudinal firing range, so it is good for the mobility of the fire force. Moreover, in addition to attacking the ground targets from a launcher on the ground, the same kind of rocket-gun can be airborne to attack targets in the air.

The scope for tactical use is broad. According to tactical requirement, rocket shell can be equipped with different warheads. For instance, the killing warhead is used to kill enemy fighting force; the antitank warhead is used to destroy enemy's tanks and armoured vehicles; the explosive warhead is used to destroy enemy's building of large area and underground defense works; the mine sweeping warhead is used to destroy enemy's mined area; and the mining warhead is used to destroy enemy's tanks and to block enemy's tank movement. In addition, there are flare warhead, screen warhead, incendiary warhead and propaganda warhead which can be used for specific purpose.

Nevertheless, rocket-gun has its shortcomings. When many rocket shells are fired simultaneously, there can be a long line of flare formed, and thereby the launching position can be easily exposed, so the enemy can launch their attack. In order to compensate such shortcoming, a tactics of "hit and run" is adopted. "To change new position after firing one round" can destroy enemy without being retaliated.

The New Progress in Satellite Navigation

By
Li Ke

In a clear night, the stars are shining in the sky. Looking at the North Star, we can tell our direction when we are walking. Those who understand astronomy can find the stars which they know from among the twinkling stars, such as the Ursa Major, the Andromeda and the Orion which seems to carry bundles of arrows around its waist. Suddenly there is a small star flying accross the night sky. Ah! It is a man-made satellite. For hundred and thousand years, this vast sea of stars has attracted imagination of great many scientists.

In the very early days, our ancesters already tried to make use of the stars to determine their position on the earth. The seafarers often depend upon their observation of the sun, the moon and other stars to determine their voyage. Since the advent of aircrafts, the pilots too make use of the stars to make their flight and to determine their position in the sky. This is the so-called stellar navigation. To use stellar navigation, however, cannot keep clear of the limit of the weather. When it is cloudy and the visibility is poor, it will be very difficult to make observations.

The Revelation of Man-made Satellite

In 1957, the flight of the first man-made satellite brought great revelation to mankind. At that time, many scientists throughout the world received the signals sent down from that man-made satellite and learned that the frequency gradually increased when it came over and the frequency began to decrease when it flied away. The signals sent down from the satellite are constant and the same, why does the frequency show difference when it is received on the earth? When a man-made satellite is flying in space, there is a relative motion to the receiver on the earth, and it makes the signal frequency change. Such phenomenon can be often seen in our daily life. When a train is rushing by, its whistle becomes louder and louder as it comes closer and closer and it becomes lower and lower when the train goes away further and further. This phenomenon was discovered by an Austrian Physicist Doppler and his explanation of the phenomenon has been called Doppler effect since. The change of tune is the change of frequency and the volume of frequency change caused by Doppler effect is called Doppler shift. The satellite orbit around the earth can be precisely calculated by using Doppler shift. Reversingly, if we can exactly know the orbit of a satellite, then we can know the receiver's position based on the Doppler shift of the wireless signal received from the satellite. The distinct advantageous point of using the wireless signal from the satellite to determine position is that it is free from weather condition. Thereupon, the satellite navigation system rises because of demand.

In 1959, the United States tried to launche a navigation satellite named "Meridian" without seccess. Next year, 1960, two navigation satellites were successfully launched. By the end of 1963, the "Meridian" navigation satellite system becomes usable entirely and it can serve the North Pole submarine for precise position-setting and make it able to lauch missiles with good accuracy. In 1967, the decoding and civil department of this satellite navigation system can also send signals by using satellite.

Now there have been six meridian navigation satellites travelling in their orbits with an altitude of 1000 kilometers and, in every 100 minutes, they fly over South Pole and North Pole once. Each satellite sends wireless signals of 150 and 400 hertz to the ground station consecutively. The orbit data in the signal of the code-sending satellite can enable the ground station to know the exact position of the satellite in its orbit when the ground station receives its signals. Thus the receiver on the ground records the Doppler shift in the wireless signal and computes it by an electronic computer, and it can determine its own position. The accuracy of postioning based on the signals sent down by a satellite is within a range of 50 meters. If the data of more than 30 flights of a satellite are collected in one day and computed by a mean computation, the positioning error can be minimized to a range of 10 meters. In order to promote the accuracy in positioning, a fixed ground station can do in this way. If the navigation receiver is set onto a ship which is moving, the speed of the ship movement must be known precisely; otherwise, the accuracy of navigation will become very poor. To an aircraft, at the interval of the time of two navigation positionings, its flying distance can cover more than 1000 kilometers. Obviously, it is not suitable to use meridian navigation satellite to navigate the aircraft.

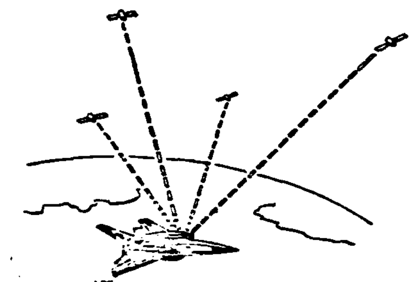

Figure 1 Navigation by receiving signals from four navigation satellites simultaneously

A New Star in Space

For compenasting the inability of meridian navigation satellite to provide required altitude, speed and continuous signals, some new navigation satellite is in the processes of studying and manufacturing. The navy requires very accurate continuous positioning signals and so are the guided missiles. The air force wants to use new navigation satellite system to navigate aircrafts of high mobility and to use navigation satellite to control the dexterous weapon to hit target s.

The new satellite navigation system is called "All-over earth positioning system". The fundamental theory of this system is to compute the distance between the satellite launcher and the navigation receiver. If the signals from three different satellites are received at the same time, and registering the time used for receiving each signal, then by using the transmitting speed of the wireless which has already been known, the position of the receiver can be calculated. Using the distance between each satellite and the receiver as radius and a satellite as center, a spherical body can be made. Thus using three satellites can make three spherical bodies. The intersecting point of these three spherical bodies is the position of the receiver. However, in order to make accurate computation, the satellite signals received must maintain synchronous in time strictly. Otherwise, "a slight error can result in serious mistakes". An error of a microsecond can result in a positioning error of more than 300 meters. Each navigation satellite is therefore equipped with atomic clock which can give time extremely accurate. Similarly, for timing precisely,

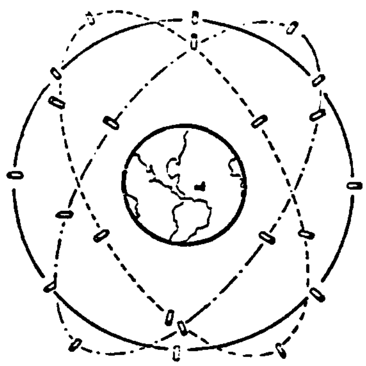

Figure 2. All-over earth positioning system is composed of 24 satellites

each receiver is also equipped with atomic clock. But this is rather costly, so there comes a plan of using another navigation satellite to give time. The receiver must therefore be made able at the same time to receive signals from four satellites. In other words, it requires that at least four navigation satellites appear in the viewing field of the receiver at the same time and make one who is to receive signals can "hear" when he can "see" (see Figure 1). At whatever place on the earth, unless the signals from four navigation satellites can be received simultaneously at any time, accurate positioning cannot be achieved. So the all-over earth positioning system requires to be composed of 24 navigation satellites which are divided into three groups each consisting of eight satellites and they can travel in each one's own orbit respectively (see Figure 2). The included angle between the orbit and equator is 63°. The time for each satellite to orbit one cycle is 12 hours.

When this all-over earth positioning system is put into use, the horizontal direction in positioning accuracy can reach five meters and the vertical direction can reach seven meters. The speed on three mutually perpendicular directions can be measured to five centimeters per second. This implies that a diminutive change of speed of an aircraft in the air can be detected by using a navigation satellite. Clearly, the navigation satellite will help to promote the exquisiteness of guidance of cruising missile and similar weapon, and the remote controlled aircrafts will greatly benefit as well. If an intercontinental missile is equipped with receiver of satellite navigation, it can use the navigation satellite to carry out control in flight so as to promote the accuracy of hitting targets.

The space aircrafts as well as the killer satellite system will use navigation satellite to make space positioning.

It is predicted that five years later, there will be 30,000 receivers to receive informations of positioning and timing sent from satellites. By that time, using one receiver which is a little larger than a pocket transistor radio of earlier days can receive the informations sent from a navigation satellite.

A navigation satellite can send messege in ordinary telegraphic code or secret code. Sending messege in secret code usually uses a random noise-making technique to mix the messege with the noise. Thus it is difficult for enemy to interfere. In own receiver, there is a corresponding deruning device which can detune the messege in secret code from the noise.

The accuracy of positioning provided by navigation satellite is very high and even the positions of the vehicles running on the street can be determined by using navigation satellite. When a ship is entering a harbor, it can also use the positioning signal sent from navigation satellite. The drilling of oil well on the sea, geographic survey and all those which require accurate positioning will all need the service of navigation satellite.

The Design of Supersonic Passenger Aircraft
(final)

by

Qiam Yongnian

The Selection and Arrangement of Power Unit

In order to have high cruising speed and good take-off performance, the take-off thrust-to-weight ratio of a supersonic passenger aircraft is always great. It, therefore, has a higher requirement for the thrust of the engine. A supersonic passenger aircraft often uses reheat turbojet engine or reheat turbofan engine with great thrust as power unit. The reheat thrust of a single engine of this kind is 17,000 to 20,000 kilograms. So when a supersonic passenger aircraft uses four engines, the take-off thrust-to-weight ratio can respectively reach 0.4 to 0.45. It almost doubles the thrust-to-weight ratio of the jumbo hypersubsonic intercontinental passenger aircraft. Moreover, the supersonic passenger aircraft has low eing load (the take-off wing load is 410-490 kilograms per square meter and the take-off wing load of a jumbo hypersubsonic intercontinental passenger aircraft is more than 500 kilograms per square meter), and this guarantees that the aircraft can have a high supersonic cruising speed, a high take-off climbing flight track and a satisfactory landing performance.

The merits of a reheat turbojet engine are that its structure is compact, specific weight low and the windward area small. When the aircraft takes off or tries to make transonic acceleration, it can through reheating make the thrust increase remarkable (it can respectively reach 22% to 26%. During supersonic flight, the turbojet engine will show its merits of high thrust efficiency and low rate of oil consumption. So it is suitable to be used as power unit of a supersonic passenger aircraft.

When a turbofan engine is used on a subsonic aircraft, it shows the merits of large take-off thrust, low rate of oil consumption in cruising flight and minimum noise. But if it is used effectively on a supersonic passenger aircraft, there must be some measure of reheating. Only so, it can show the merits of having great reheat thrust, good acceleration characteristic and low rate of oil consumption. Not only is it convenient for taking off but it is also applicable to supersonic cruising flight. So a reheat turbofan engine can be used as power unit of a supersonic passenger aircraft.

The reheat combustor of these two kinds of engines can work for a very long period of time without any time limit.

One of the important problems of arrangement in a supersonic passenger aircraft is the placement of engines as well as the design of inlet channel. It should guarantee that, during supersonic cruising flight, the total pressure recovery coefficient at the inlet of the engine can be as large as possible (as the total pressure recovery coefficient increases, the thrust increases and the consumption of oil becomes low), and that the outer resistance of the short cabin of the engine can become minimum.

In order to reduce frontal resistance, the engine is set in a form of "semi-buried" (it closely contacts the under-surface of the wind). The passenger aircraft "Concorde", for instance, has its four engines set two on each side parallel in the short cabin of the under-surface at the rear part of the wing that keeps a certain distance from both sides of the body. In front of the short cabin, there is a two-dimensional (rectangular section) adjustable inlet channel of multiwave (see Figure 9). The inlet opening which has proper length-width ratio is made in an askew shape, so it can reduce resistance. Placing the engine underneath the wing, on the one hand, can enable the engine to make use of the natural high pressure zone of the wing under-surface, and on the other hand, the side wall of the short cabin and the wing under-surface can produce advantageous interference effect, which will help the wing to have additional lift force.

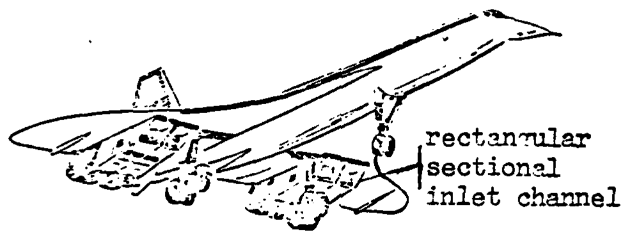

Figure 9

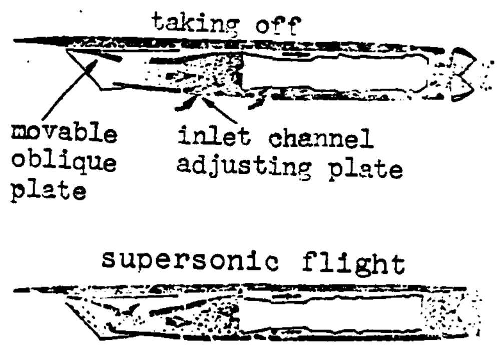

Figure 10